Waves in the Marginal Ice Zone

U.S. NAVAL RESEARCH LABORATORY

AT A GLANCE

What is it?

A comprehensive investigation of wave propagation through fields of ice floes, combining modeling, theory, and lab experiments.

How does it work?

Experimental data are used to validate theoretical and model-based predictions of wave attenuation, boundary layer dynamics, and ice floe migration. Models are then adapted and calibrated to provide forecasts of ice conditions for future polar expeditions and deployments.

What will it accomplish?

A better understanding of wave-ice physics will improve the Navy's predictive capability in polar regions, increasing confidence in forecasts of wave propagation & ice location by operational Navy models. This will help make deployments to these challenging environments both safer and more effective.

R&D Sponsor(s)

Office of Naval Research

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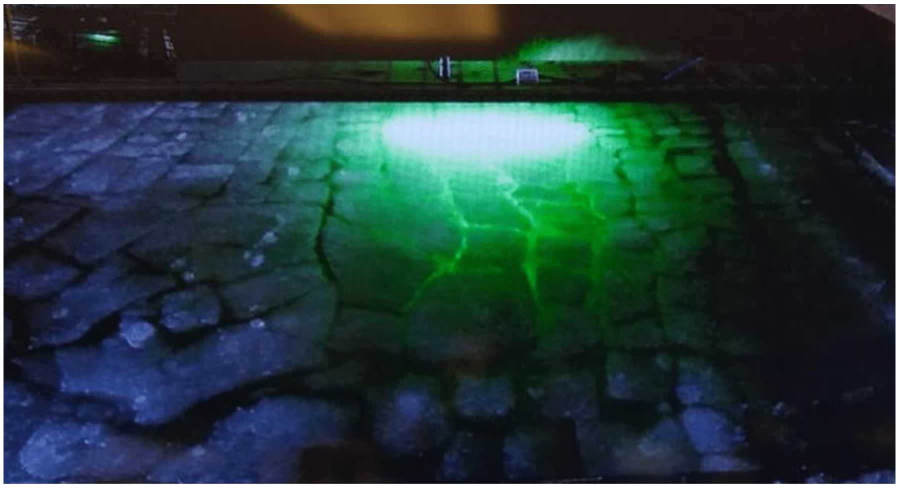

Measuring waves in ice with subsurface laser PIV at CRREL FRF

The interaction of ocean surface waves with ice floes in polar regions is a complex process about which much remains unknown. As the Earth's temperature continues to rise and the Arctic region becomes more navigable, it is increasingly important to understand and accurately predict both the ice effects on waves (e.g., wave attenuation and scattering) and the wave effects on ice (e.g., formation and growth of new ice, fracturing and retreat of ice sheets). In a feedback loop, ice retreat causes the wind–wave fetch to increase in the open ocean, which allows waves to grow more powerful and further damage the ice, accelerating the retreat rates. In the spring and summer months, a growing proportion of the remaining Arctic ice cover turns into a field of fractured separate ice floes—what has typically been called the "marginal" ice zone (MIZ)—but increasingly spreads throughout the warmer Arctic region.

In this ongoing basic research project at NRL-South, we are investigating the interactions between waves and ice at small scales, focusing primarily on attenuation of wave energy by the ice, the horizontal forces acting to shift the ice around, and the role played in these processes by the fluid boundary layer that develops beneath the ice. We have completed two laboratory experiments in which we used a laser PIV system (right) and sonic altimeters to map fluid motion under the ice and measure resulting wave attenuation. Preliminary results from the experiments compare well with theory and model output, showing clear evidence of a boundary layer at the ice-water interface and greater attenuation for longer period waves (for additional details, see *Orzech et al., JMSE 2022* and *Yu, JMSE 2022*).

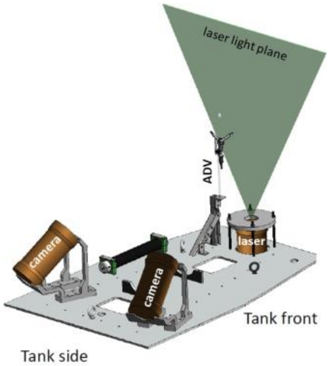

Diagram of Laser PIV System